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(71) Applicant: SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.
Carel van Bylandtlaan 30
NL-2596 HR Den Haag(NL)

(72) Inventor: Coffman, Paul Mahoney
1819 Cherry Bend Drive
Houston Texas 77077(US)
Inventor: Miller, Charles Ralph
101 Ambrose Hill
Williamsburg Virginia 23185(US)

(74) Representative: Aalbers, Onno et al
P.O. Box 302
NL-2501 CH The Hague(NL)

(54) **Hot fill thermoplastic container.**

(57) A process for hot filling a thermoplastic container so as to avoid deformation and collapse of the container, resulting in a container with a concave base which comprises the steps of continuously applying a vacuum means to the base of a thermoplastic container so as to draw down the base of the container into a convex shape, filling the container with desired contents during continuous application of the vacuum means, sealing the container by an appropriate sealing means during continuous application of the vacuum means, discontinuing the vacuum means, and cooling the container, whose base, in the absence of the external vacuum, inverts to a concave shape, which was its original formed shape.

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HOT FILL THERMOPLASTIC CONTAINER

This invention relates to a method of hot filling a thermoplastic container. More particularly, this invention relates to a method of hot filling a thermoplastic container so as to avoid deformation and collapse of the container under internal vacuum caused by subsequent cooling of the container and contents.

When foods are packaged in rigid containers, they are frequently filled with liquid food stuffs at an elevated temperature of about 190 or 200 °F to destroy bacteria. This is referred to as "hot filling". After the filling, the head space is often purged with inert gas to reduce the oxygen content and the lid or closure is sealed while the contents are still hot and the sealed container is then cooled to room temperature. At the hot fill temperature, the vapour pressure of water is about 10 psi or 500 mm of Hg. Sealing takes place at atmospheric pressure of 15 psi so that the head space in the can may very well be occupied more by water vapour (by volume) than by air or inert gas. When the can is cooled, the water vapour pressure is reduced to a level of only about .5 psi and the water vapour in the head space condenses, thus creating a vacuum. This vacuum could be as much as 9 psi if the air space has been saturated with water vapour, but usually the air space does not approach the saturation point so that the vacuum created is typically in the region of one to three psi. However, this is still enough to cause vacuum collapse of many plastic containers.

Plastic containers having flexible bottom walls to accommodate the development of a vacuum within are well known and commercially available. U.S. Patent No. 4,255,457 and U.S. Patent No. 4,219,578 are both concerned with an anti-buckling device for beer cans. They disclose the use of an anti-buckle ring which braces the can's interbase wall and first and second radius portions from substantially interradial displacement.

U.S. Patent No. 4,125,632 discloses a method for the production of a container body which is originally manufactured with a convex base. The material in the convex base is thinner than that in the side wall.

U.S. Patent No. 3,409,167 discloses a flexible bottom which accommodates an internal vacuum.

Reissue U.S. Patent No. 31,762 discloses a container which, as originally manufactured, contains a side wall convex "bulge".

U.S. Patent No. 4,459,793 involves the use of an interplastic liner within a metal can to absorb the vacuum shrink, but without any controlled volume change of the primary metal can.

U.S. Patent No. 4,125,632 provides a weak bottom for collapse in preference to the side walls but without any controlled volume change or use of vacuum draw down.

One solution has been to make the container walls and base very thick so that they can resist collapse, but this is economically unattractive and sometimes difficult to accomplish. Applicant's idea is aimed at artificially increasing the internal pressure within the container, thus reducing the vacuum and the tendency of the side walls to collapse.

Applicant's invention comprises a method of hot filling a thermoplastic container so as to avoid deformation and collapse of the container, resulting in a container with a concave base which comprises the steps of continuously applying a vacuum means to the base of a thermoplastic container so as to draw down the base of the container into a convex shape, filling the container with desired contents during continuous application of the vacuum means, sealing the container by an appropriate sealing means during continuous application of the vacuum means, discontinuing the vacuum means, and cooling the container, whose base, in the absence of the external vacuum, inverts to a concave shape, which was its original formed shape.

Figure 1 illustrates the thermoplastic container as originally manufactured, which has a concave base.

Figure 2 illustrates the continuous application of vacuum means to the base of the container to draw the base into a convex shape.

Figure 3 illustrates the sealing of the filled container during continuous application of the vacuum means.

Figure 4 illustrates the cooling of the container after the vacuum has been discontinued where the base of the container has inverted to its original concave shape or something approaching same.

Figure 5 illustrates the use of a positive stop device during draw down of the base of the container by vacuum means.

Containers are typically hot filled and packaged with enough air space so that after cooling 10% or more (sometimes much more) of the volume of the container will remain filled with air of some inert gas used to reduce the oxygen content. This is to prevent spillage upon opening the container by the consumer. The air space at equilibrium before cooling contains about two thirds by volume water vapour, and after cooling only about 3% water vapour. If the container remains rigid, as in the case of a metal can, a vacuum of about 10 psi can result. Plastic containers do not possess the rigidity

of metal cans and thus collapse under very slight vacuum often as little as 1 psi. This means that a volume change equal to more than half of the initial air volume is required to eliminate the vacuum.

The container 8 of the present invention is constructed with a base 10 which may be bowed upward into a concave shape as illustrated in Figure 1. This, of course, is a normal configuration of the container so the container will sit flat on a table and be easily stacked for transportation and storage. At the point of hot filling, as seen in Figure 2, vacuum is applied continuously to the underside of base 10 of thermoplastic container 8 so as to draw down base 10 of container 8 into a convex shape. This increases the volume of container 8. Container 8 is now filled with desired contents 12 during continuous application of the vacuum means 11.

As seen in Figure 3, the cover seal 13 of the container 8 is attached by an appropriate sealing means still during continuous application of vacuum.

In Figure 4, vacuum is discontinued and container 8 is cooled so that base 10 of container 8 inverts to a concave shape. By reducing the volume of container 8 after sealing, the head space is reduced thus compressing the air therein and creating a positive internal pressure which will reduce the vacuum created upon cooling. The amount of positive pressure created will be proportional to the ratio of the head space before and after the suck down vacuum is released. In most cases, inversion of base 10 will take place spontaneously. If not, some typ of mechanical assist may be used to achieve inversion.

Figure 5 illustrates an optional use of a positive stop device 14 which is adjustable to allow regulation of the amount of draw down desired for container 8. Positive stop device 14 allows a uniformity of draw down of the containers to be achieved. The container may be placed upon a structure 16 with an aperture 18 therewithin corresponding to the area of base 10 of container 8. Vacuum is pulled under structure 16 to suck or draw down base 10 from an upward concave shape to a downward convex shape. The use of the positive stop device 14 is only one of many methods which may be used to achieve the desired draw down of base 10. The original base 10 of the originally manufactured container may be of a concave shape or may be flat. The original base 10 is preferably in a shape other than a concave shape. Concave is defined as "a rounding or curving inward". Convex is defined as "a rounding or curving outward".

EXAMPLE 1

A 500 mil margarine tub which normally holds 500 mils of product with 50 mils of head space may be used as an example. The full overflow volume would be 550 mils. This container may be sucked down or drawn down until the volume becomes 600 mils. The container is filled with 500 mils of liquid at 200 °F and sealed. (This results in 100 mils of head space which contains 100 mils of air and water vapour at 15 psia. Depending on the degree of saturation, the water vapour can be anything from a negligible amount to 65 mol% of the vapour. For example, the water vapour can represents 7.5 psi of the total 15 psi and air can represent the other 7.5 psi). Upon releasing the vacuum, the base snaps up and reduces the head space to 50 mil, thus compressing the air by a factor of two and raising its partial pressure to 15 pounds. When the contents are cooled, the water vapour condenses out and drops to a partial pressure of about .5 pounds. It is possible to vary the volume change by varying the draw down vacuum of course. One means of achieving this of course, is by use of a positive stop device which may be adjusted for varying draw down ratios. The container which results is significantly free of deformation and collapse of the side walls.

EXAMPLE 2

A fluted cranberry cup of 500 ml product capacity designed to hold 500 ml of product with 100 ml of vapour space. The base is drawn down into a convex shape by vacuum so that the volume becomes 700 mils. Upon filling with 500 mils of product at 200 °F and sealing with vacuum on, it results in 200 mils of head space consisting of air and water vapour at 15 psi. If we assume the pressure of water vapour in the head space is 7.5 psi, then the air or nitrogen pressure is also 7.5 psi. Upon release of the vacuum, the base snaps up and reduces the head space to 100 mils, thus compressing the vapour volume by a factor of two and raising the total pressure to about 30 psi. When the contents are cooled, the water vapour condenses out and drops to a water partial pressure of about .5 psi. The pressure of nitrogen is 15 psi, thus the total internal pressure is about 15.5 psi. The container which results is significantly free of deformation and collapse of the side walls.

The sealing of the containers may be by use of any standard sealing mechanism which may include paper, foil or other types of covers which may be attached by adhesives, heat welding, sonic welding, or double seaming or any other method.

It will become apparent that it is much easier for the base of the container to snap back to a more original, familiar position than it would be to snap into a totally new position, such as is the case in some of the patents which provide for manufacture of a container which originally contained a convex base. In addition, the base of applicant's invention does not have to be made of thicker-walled material. Likewise, with use of an external vacuum, the amount of draw down and pressure necessary for producing the convex base can be controlled depending on the level to which the contents are filled within the container.

Claims

1. Process of hot filling a thermoplastic container, so as to avoid deformation and collapse of the container, which results in a container with a concave base, which comprises the steps of:
continuously applying a vacuum means to the original base of a thermoplastic container so as to draw down said original base of said container into a convex shape;
filling said container with desired contents, during continuous application of said vacuum means;
sealing said container by an appropriate sealing means during continuous application of said vacuum means;
discontinuing said vacuum means and
cooling said container so that said base of said container inverts to a concave shape.

2. Process as claimed in claim 1, wherein said original base of said container is drawn down into a convex shape by continuously applying said vacuum means to said original base of said thermoplastic container, wherein a positive stop device is positioned beneath said original base of said container as said vacuum means is applied to said original base.

3. Process as claimed in claim 1 or 2, wherein prior to continuously applying said vacuum means to said original base of said thermoplastic container, said container is placed upon a structure, said structure containing an aperture within, which aperture corresponds to said original base of said container.

4. Process as claimed in any one of claims 1 to 3, wherein said container is originally manufactured wherein said original base is in a shape other than a concave shape.

5. Process as claimed in any one of claims 1 to 4, wherein said container is originally manufactured with said original base in a concave shape.

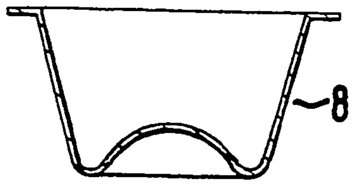

FIG.1

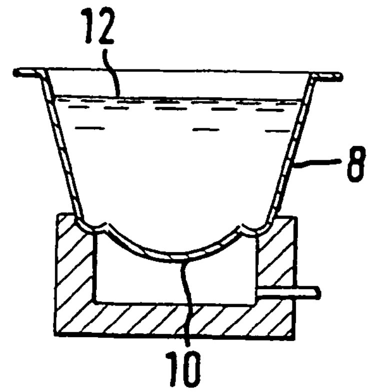

FIG.2

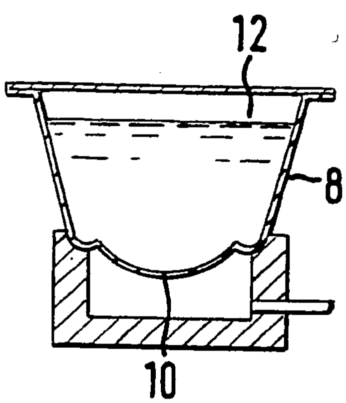

FIG 3

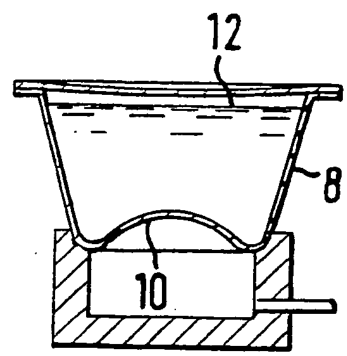

FIG.4

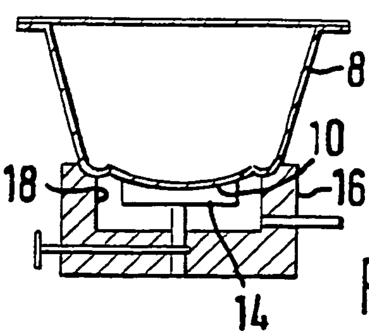

FIG.5

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EUROPEAN SEARCH REPORT

Application number

EP 86 20 2244

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	EP-A-0 068 718 (AMERICAN CAN) * Page 8, line 12 - page 11, line 26; figure 6 * ---	1,5	B 65 B 3/04 B 65 B 61/00
A	CH-A- 524 504 (FISCHER) * Whole document * ---	1	
A	FR-A-2 102 047 (TETRA PAK) * Page 2, lines 9-22; figure 2 * -----	4	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			B 65 B B 65 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-04-1987	CLAEYS H.C.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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